Space Weather Technical Forecast

Issued on Thursday, 12 January 2023 at 00:40 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: M-class flares likely. Chance of X-class flares (R3; Strong radio blackouts) throughout. A possible glancing blow from a CME later on the 12th January.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate over the past 24 hours. Several M-class flares were observed, the largest an M5.6 flare at 11/0156 UTC from AR3184, in the southeast. There are currently five numbered and two un-numbered sunspot regions on the visible disc. AR3182 and AR3181 in the southwest quadrant remain complex regions. However, both of these regions appear to be mature and in a slight overall decay phase. AR3184 located in the far SE quadrant is now the largest region on the disk and retains a Delta configuration in its intermediate portion which makes it the most magnetically complex. AR3186 in the far northeast continues to show growth, however it appears to have lost its Delta configuration. AR3185 continues to show small spot development. AR3180 and AR3183 have rotated off the west limb. AR3187 decayed to plage. A pair of small spots has now rotated into view at the southeast limb, however accurate analysis is very difficult at present due to viewing angle. This group is tentatively given a Bxo/Beta classification. A further NEW region has emerged in the northern hemisphere near the centre, this is also a weak Bxo/Beta.
No Earth-directed CMEs have been observed in available imagery in the period.

Solar Wind / Geomagnetic Activity: Solar winds, as observed by DSCOVR at L1, started the period at slow-ambient levels but have drifted erratically above the slightly-elevated level, average around 410 km/s. Density was mostly average or below average. Total IMF, Bt, was predominantly weak, with a few peaks at 9 nT. The north-south component, Bz, alternated between short periods of negative (southward) and positive (northward) but was also weak, +7/-7 nT. Phi angle was generally negative (towards the Sun). Geomagnetic activity was Quiet (Kp 1-2).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES-16 was at background levels. High energy electron flux (greater than 2 MeV) has been at background levels. The 24-hour integrated electron fluence stayed well below the Active threshold, reaching 2.62e6 integrated pfu at 11/2359 UTC.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to be Moderate, with a continuing daily chance of X-class flares through the forecast period, these most likely from AR3182, AR3181, AR3184 or AR3186.

Solar Wind / Geomagnetic Activity: The M2 flare on 9th Jan from AR3181 in the southwest generated a CME, which could give a glancing blow at Earth later on day 2 (12th Jan), although this is a low probability. No other Earth-directed CMEs are in the forecast.
Solar wind speeds are at slightly-elevated levels, perhaps as a result of weak connection with CH62/-. Geomagnetic activity is expected to be Quiet to Unsettled. During day 1 (12th Jan) there is the low chance of a glancing blow from the aforementioned 9th Jan CME, which may increase geomagnetic activity to Unsettled to Active with a slight chance of a G1 minor geomagnetic storm, potentially lasting into day 2 (13th Jan), however this is low confidence. Otherwise, geomagnetic activity should remain at generally Quiet levels.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux observed by GOES-16 is likely to remain at background levels throughout. However, there is a risk of an increase should any significant flares occur, giving a slight chance of exceeding the S1/Minor Storm threshold. Electron fluence is likely to remain below the Active (1e8 integrated pfu) threshold, but a limited rise is possible depending on extent of coronal hole influence.

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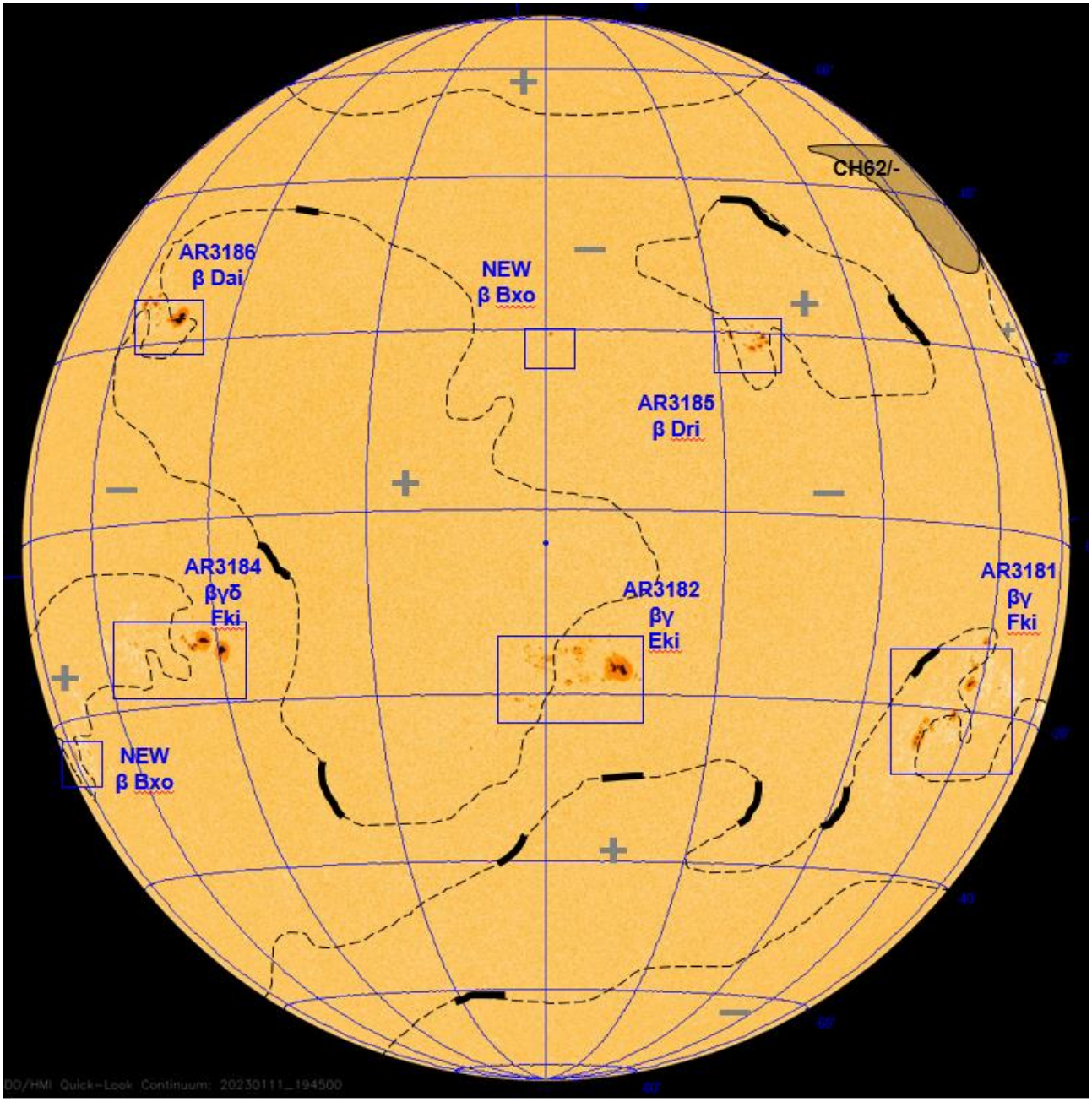
Figure 1. Solar Analysis Valid 11/2000 UTC.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

AR3181 in the southwest produced an M2 flare, observed at 09/0901 UTC, which produced a CME. This has been analysed and may give a glancing blow at Earth later on Day 1 (12 Jan), although this is low confidence. No other Earth-directed CMEs are currently expected in the forecast.

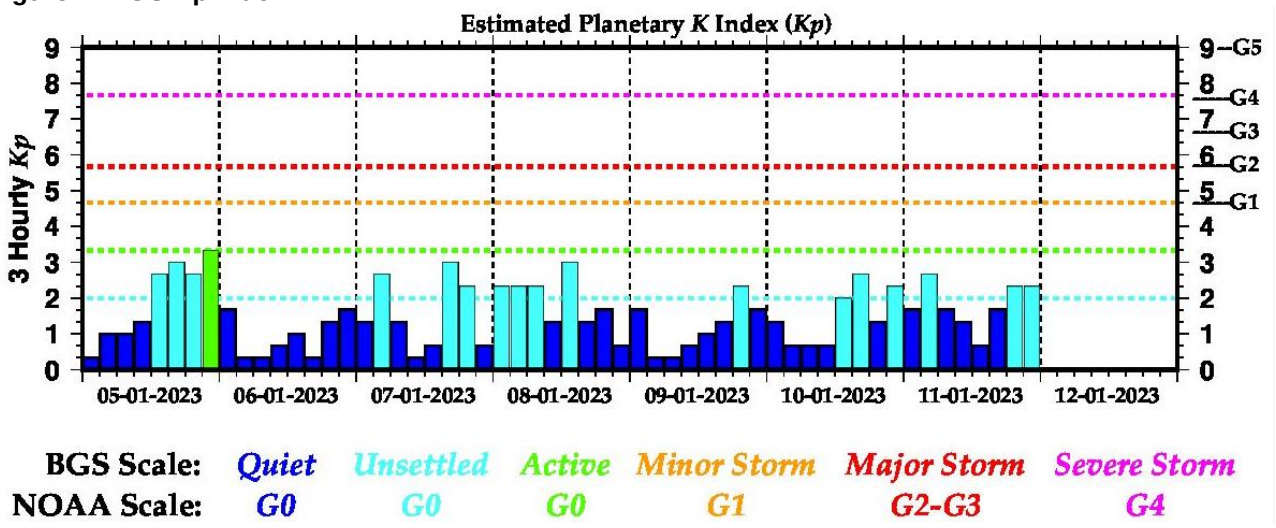
Solar wind speeds are at slightly-elevated levels, perhaps as a result of weak connection with CH62/-. Geomagnetic activity is expected to be Quiet to Unsettled. During day 1 (12th Jan) there is the low chance of a glancing blow from the aforementioned 9th Jan CME, which may increase geomagnetic activity to Unsettled to Active with a slight chance of a G1 minor geomagnetic storm, potentially lasting into day 2 (13th Jan), however this is low confidence. Otherwise, geomagnetic activity should remain at generally Quiet levels.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	10	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
09/1908	Partial	AR3181	S30W31	445km/s	12/2100UTC	Low probability of glancing blow

Figure 2: BGS Kp index


Estimated Planetary K Index (Kp)
3 Hourly Kp
9 8 7 6 5 4 3 2 1 0
G5 G4 G3 G2 G1
05-01-2023 06-01-2023 07-01-2023 08-01-2023 09-01-2023 10-01-2023 11-01-2023 12-01-2023
BGS Scale: Quiet Unsettled Active Minor Storm Major Storm Severe Storm
NOAA Scale: G0 G0 G0 G1 G2-G3 G4

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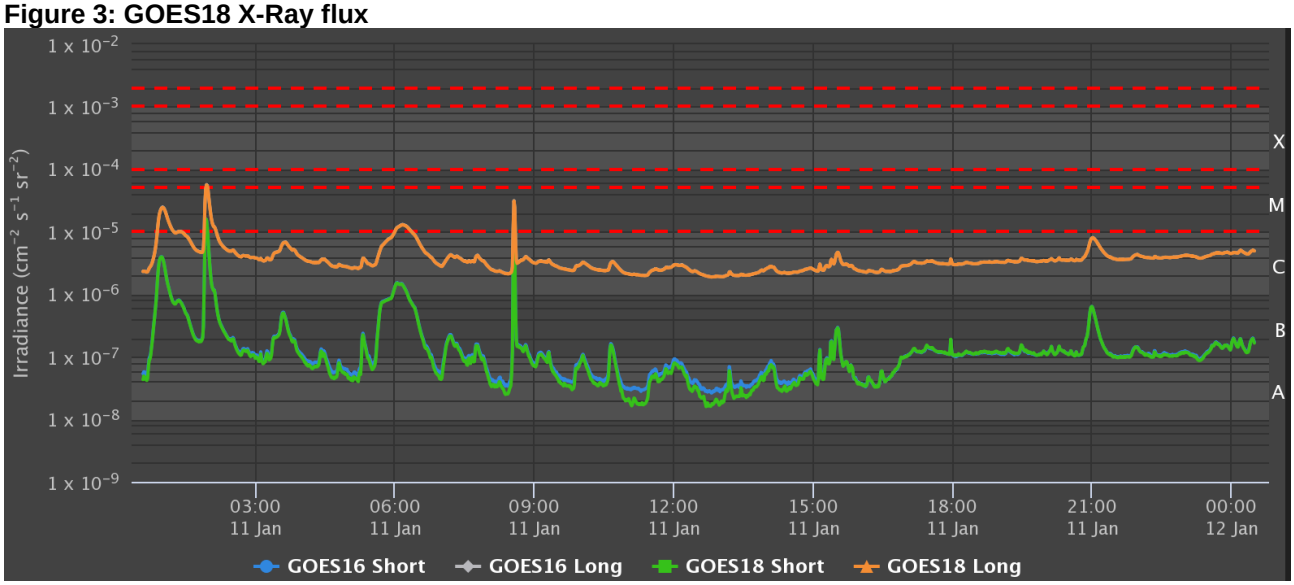
Radio Blackouts - X-Ray Flares:
Solar activity has been Moderate in the past 24 hours, with several M-class flares observed, the largest an M5.6 flare at 11/0156UTC from AR3184, in the southeast.

There are currently five numbered and two un-numbered sunspot regions on the visible disc. AR3182 and AR3181 in the southwest quadrant remain complex regions. However, both of these regions appear to be mature and in a slight overall decay phase. AR3184 located in the far SE quadrant is now the largest region on the disk and retains a Delta configuration in its intermediate portion which makes it the most magnetically complex. AR3186 in the far northeast continues to show growth, however it appears to have lost its Delta configuration. AR3185 continues to show small spot development. AR3180 and AR3183 have rotated off the west limb. AR3187 decayed to plage. A pair of small spots has now rotated into view at the southeast limb, however accurate analysis is very difficult at present due to viewing angle. This group is tentatively given a Bxo/Beta classification. A further NEW region has emerged in the northern hemisphere near the centre, this is also a weak Bxo/Beta.

Far side seismographs are also indicating plenty of additional potential activity on the far side, and there are signs on SDO imagery of another large active region appearing on the southeast limb with flux looping evident and some magnetic structure on magnetogram products.
Solar activity is expected to be Moderate with a chance of further X-class flares. AR3182, AR3181, AR3184 or AR3186 are the most likely regions to produce further significant flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	80	80	80	80
Very Active	R3 to R5 X Class	No	25	25	25	25

Figure 3: GOES18 X-Ray flux



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) measured by GOES-16 has been at background levels. However, any significant flares will bring a risk of proton flux rising, with a slight chance of exceeding the S1/Minor Storm threshold. This is mainly due to the risk presented by both AR3182 and AR3181 as they are now rotating further westwards across the disc, towards a position where they are more likely to connect with Earth for proton storm events. AR3184 will also bear watching in the coming days, depending on how it appears and potentially develops as it rotates more fully across the visible solar disc.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	20	20	20	20
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) has been at background to moderate levels. Any rise in activity is expected to be modest, perhaps reaching Moderate levels at the diurnal peaks. Any glancing blow from a CME later on day 1 (12 Jan) could also keep electron flux levels suppressed.

Electron fluence is expected to remain below the Active (1e8 integrated pfu) threshold through the period. Confidence in fluence remaining below Active through most of the period is high, but lower for the likelihood and timing of any possible increase due to the extent of any coronal hole influence.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	5	10	20
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

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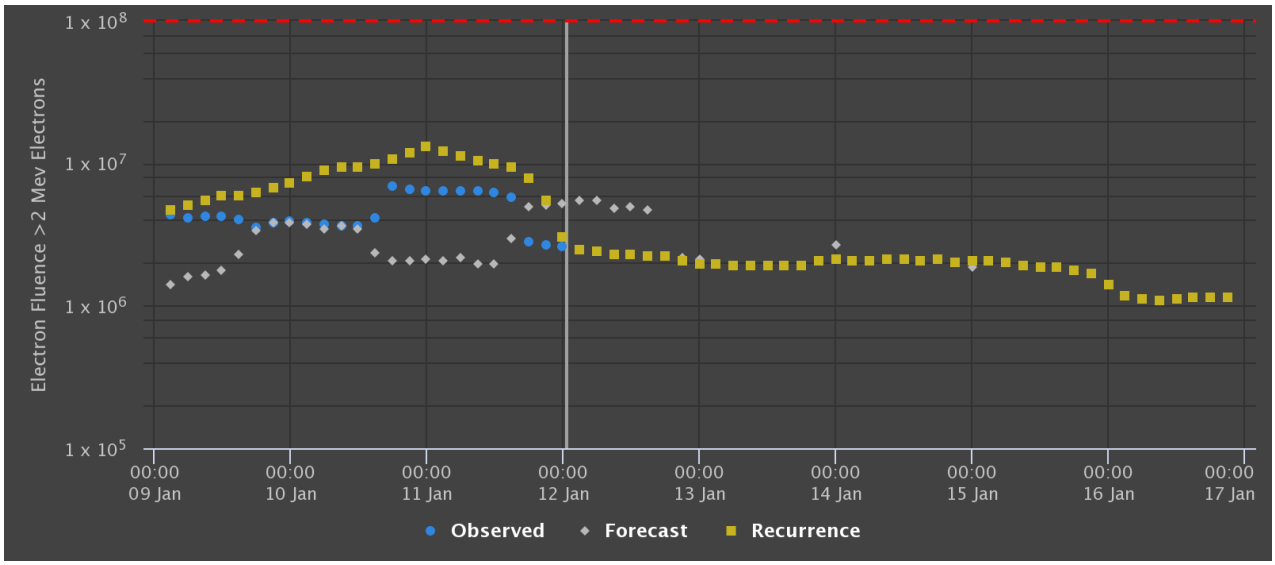
Figure 4: MOSWOC REF Model



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